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# UNU & WHO Survey on E-waste and its Health Impact on Children

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# EXECUTIVE SUMMARY

As a result of international commitments, such as the Busan Pledge for Action on Children' Environmental Health (Busan, 2009) and the Libreville Declaration (that came out of the 1st Inter-Ministerial Conference on Health and Environment in Africa), the World Health Organization (WHO) was urged to work on the emerging issue of electronic waste and specifically its impact on the health and development of children.

Following the launch of a new initiative by WHO addressing electronic waste and child health, the United Nations University (UNU), which hosts the Solving the E-waste Problem (StEP) Initiative, and WHO carried out an on-line survey with a wider body of experts. The survey aimed to identify existing knowledge and key stakeholders working on e-waste and child health that could contribute to and benefit from the new initiative's findings.

International experts were invited to contribute to this initiative by responding to a short on-line survey within a 4 week time-frame. The findings were discussed in a closed WHO working meeting on e-waste and child health, held in Genève between the 11-12 June 2013.

The survey highlighted the need for joint action to tackle health issues related to e-waste management around the world. These efforts, led by WHO, should complement existing activities of other organizations, to use and build on the expertise of complementary disciplines. This will ensure a holistic approach, taking into account the challenges of proper e-waste management in different regions of the world.

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## INTORDUCTION ON E-WASTE CHALLENGES

Over the last decades the electronics industry has revolutionized the world: electrical and electronic products have become ubiquitous of today's life around the planet. Without these products, modern life would not be possible in (post-) industrialized or industrializing countries. These products are used in such areas as medicine, transportation, education, health, food-supply, communication, security, environmental protection and culture. Common appliances include many domestic devices like refrigerators, washing machines, mobile phones, personal computers, printers, toys and TVs.

They are discarded at end-of-life – sometimes after re-use cycles in countries different from those where they were initially sold – becoming what is commonly called e-waste. E-waste is usually regarded as a waste problem, which can cause environmental damage and human health if not safely managed. Treatment processes of e-waste aim to either remove the hazardous components or as much of the main recyclable materials (e.g. metals, glass and plastics) as possible; achieving both objectives is most desired.

It has been over a decade since national and international regulatory authorities began to develop policies to address the challenge of sound e-waste processing. The complexity of actively involving all relevant stakeholders and agreeing on respective responsibilities posed significant challenges to implementing these policies. However, stakeholders involved in the electronics recycling chain have gained experience in overcoming the challenges associated with developing sound legislation. End-of-life (EoL) electronics have garnered significant interest among policymakers because they are a waste stream with a unique combination of characteristics:

- First, levels of EoL electronics, or "e-waste", have been increasing and are expected to continue to rise.
- Second, e-waste contains materials that are considered toxic, such as lead, mercury, cadmium, arsenic, PBDEs, PCBs, PCDD/Fs and PFAS which are harmful to the environment and human health. Safe disposal is very complicated.
- Third, the mixtures of toxic substances found in e-waste are often unique and not well studied.
- Fourth, e-waste contains valuable materials and recovery of these materials can alleviate mining of virgin materials.
- Finally, in many cases the costs of recycling e-waste exceed the revenues generated from the recovered materials. This is primarily due to the complexity of product design and difficulty of separating highly commingled materials.

These concerns have led policymakers across the world to create systems to collect and process e-waste, also known as "take-back systems". E-waste poses diverse challenges, involving environmental, economic, social, and health aspects, whereby all stakeholders need to participate in the development and the implementation of solutions. In particular:

- **No "one-size-fits-all" or "turn-key" solutions for the e-waste problem exist**. Each individual country is characterized by different cultures, differences in economic development, varying statuses of e-waste legislation, and varied recycling and e-waste management infrastructure. As a result a proper assessment should be carried out, to investigate economic, environmental and social implications in order to develop solutions tailored to regional, domestic and local conditions.
- **The complexities of recycling chains do not always allow local solutions for complete recycling of all waste streams**. Efficient recovery of natural resources sometimes requires the use of state-of-the-art recycling technologies, as well as proper disposal of hazardous components. Capital investments are needed to ensure efficient processes, including proper maintenance, monitoring of environmental performances and proper training of employees. Only certain economic circumstances can ensure the long-term sustainability of these companies.
- **Only proper involvement and collaboration between all stakeholders can lead to efficient solutions, taking into account environmental, economic and social perspectives**. The complexity of designing an effective e-waste recycling chain requires the active engagement of all stakeholders. Interests, capabilities, and roles of all actors involved should be carefully evaluated.

# PROMOTERS & SPONSORS

The first survey on health impacts of e-waste has been carried out in the framework of a joint cooperation between WHO and UNU, with special thanks to the financial support of the German Federal Ministry of Environment (BMU).

## WHO

The primary objective of the World Health Organization (WHO) is "the attainment by all peoples of the highest possible level of health”. As the primary international organization addressing health issues, WHO is uniquely placed to provide expertise on health policy, research, and intervention, while facilitating relationships between United Nations organizations, national and international organizations, national governments, researchers, and non-governmental organizations.

The WHO Department of Public Health and Environment (PHE) works to prevent environmental threats to human health through the support of targeted research, the creation of effective primary interventions and by promoting evidence-based policies and recommendations. In partnership with a network of collaborating centres, formal partners and informal partners, the WHO Children’s Environmental Health (CEH) Unit is involved in collaborative research coordination, research communication, capacity building, education and awareness raising, and the development of interventions to reduce the health effects of hazardous environmental exposures in children.

Recognizing the lack of health perspectives in international discussions of e-waste management, and in particular the vulnerability of children working in or living near e-waste recycling facilities, WHO initiated an e-waste and child health project in 2009. The project has brought together international experts from many backgrounds to address the issue of the effects of exposures to hazardous e-waste compounds during childhood and key windows of development. The key aims of the initiative are to define exposures to e-waste that may threaten the health of children and identify measures to protect children and vulnerable populations from negative health effects.

## UNU-ISP: SCYCLE

The mission of the United Nations University is to contribute, through collaborative research and education, dissemination, and advisory services, to efforts to resolve the pressing global problems of human survival, development and welfare that are the concern of the United Nations, its Peoples and Member States.

In pursuing this mission, UNU conducts research on problems of relevance to the United Nations and its Member States, offers postgraduate programs that prepare people for science-based work in the United Nations or Governments of Member States, and functions as a think tank for the United Nations and its Member States. In doing so, UNU pays due attention to the social sciences and the humanities as well as the natural sciences. UNU also acts as a bridge between the United Nations and the international academic community, and serves as a platform for global and local dialogue and creative new ideas. Through postgraduate teaching and research, UNU contributes to capacity building, particularly in developing countries.

UNU-ISP SCYCLE, located in Germany, is UNU-ISP’s first Operating Unit and became operational on 1 January 2010. It integrates the activities of the former UNU/ZEF European Focal Point into its framework. The intent of SCYCLE is to contribute to UNU-ISP objectives, primarily by:

*Enabling societies to reduce the environmental load of the production, use and disposal of especially but not exclusively, electrical and electronic equipment to sustainable levels through the development and promotion of independent, comprehensive and practical research as a sound basis for policy development and decision making.*

SCYCLE also hosts the Secretariat of the StEP (Solving the E-waste Problem) Initiative. StEP was launched in March 2007 and now consists of more than fifty stakeholders from industry, academia, government, international organizations and civil society committed to the development of applicable, holistic, science-based recommendations concerning the increasing e-waste problem. It also intends to expand the work of the Electronics Recycling Group (ERG) by extending its world-wide university network for post-graduate training and among others through the continuation of the StEP E-waste Academy Series. It supports the realization of a more sustainable industrial-societal system (in which, for example, the waste products of one industry or sector become value-added inputs for another).

While there are many research centres focusing on production and consumption, SCYCLE is unique as its concept embraces a holistic approach, while its operations converge on the nexus of policy, design, re-use, recycling and capacity building, an approach that provides additional entry-points for essential multi-stakeholder collaborations.

## STEP INITIATIVE

Each day a vast number of electrical and electronic devices end up as waste; some of them ready for disposal, others just obsolete. Because the increasing amount of electronics entering the waste stream is gradually mounting up to a serious environmental problem, StEP identified the need for scientific analysis and goal-oriented dialogue from a neutral, scientific-based standpoint in order to find solutions that reduce environmental risks and enhance development.

Based on this, the StEP Initiative was developed in late 2004 and has since grown to a 65+ member initiative as of today. As its name already says, StEP is an initiative, i.e. a network of actors who have joined to exchange ideas and experiences and work with each other toward the realization of common aims.

StEP's activities are carried out through its five Task Forces, each addressing one component of the complex e-waste value chain. In each Task Force StEP uses an interdisciplinary lens and undertakes a cross-cutting, life cycle approach to the complexities of the e-waste problem. Because political and legislative guidelines and frameworks influence design, re-use and recycling activities, Task Force 1 "Policy and Legislation" acts as a cross-cutting Task Force as its results and pilot-projects directly and indirectly impact Task Forces 2-4, "ReDesign", "ReUse" and "ReCycle" respectively. Task Force 5 "Capacity Building" also takes on a cross-cutting role by disseminating the results and achievements of the other Task Forces but also by providing a platform to gain from the insights gathered and experiences made by the other Task Forces. In this sense StEP's inter-Task Force approach and organizational structure aims toward providing holistic, systems-oriented solutions to the intricacies along the e-waste spectrum.

StEP's prime objectives are:

- Optimize the life cycle of electrical and electronic equipment
- Improve supply chains and close material loop
- Reduce contamination
- Increase utilization of resources and promote re-use of equipment

- Exercise concern about disparities such as the digital divide between the industrializing and industrialized countries

- Increase public, scientific and business knowledge

## SURVEY STRUCTURE

The online survey (https://www.surveymonkey.com/s/ewasteandhealthimpacts) has been designed with two primarily aims:

- Involve key stakeholders in the field of public health and e-waste management including experts from the electronic industry, recycling industry, UN bodies, governmental and non-governmental organizations, academics and scientists
- Map and organize existing knowledge, expertise and experiences

These two elements serve to shape and guide future activities of WHO on the issue of e-waste and children's health.

The survey has been structured in different sections, allowing skip-logic functions for some questions/sections in order to make sure each participant was responding to questions relevant to his or her background and expertise, while ensuring an effective use of the respondents' time. The main sections of the survey were divided into various segments:

- Personal and contact information of respondent, including professional background,
- Evaluation of risk profiles associated with electronic and electrical equipment (EEE) including main components and substances,
- Overview of on-going projects in the e-waste field and specific activities with a children's health focus,
- Usage of protective equipment and tools and their effectiveness in preventing and mitigating health and safety consequences,
- Main exposure risks and consequences,
- Future outlook and engagement of stakeholders.

In the following chapters, the results are presented and discussed, highlighting the main outcomes generated from the survey.

## RESULTS AND FEEDBACKS RECEVIED

The online survey was officially launched on 8th of May 2013 and was officially open until 1st June 2013. The survey was disseminated through the StEP Initiative and UNU network as well as through WHO and their network of formal and informal partners involved in Children's Environmental Health. The survey was also announced through social media (Linkedin, twitter, Facebook) by the E-waste Academy, the capacity building program of the StEP Initiative targeting scientists and managers from developing countries.

Within the timeframe allowed 112 answers were collected. The online survey has not been closed and answers are still being collected (139 answers are to date counted). The following paragraphs will analyse the answers collected in the official time-frame of the survey. The full set of answers received till 1st June 2013 is included as Annex 1 of this report.

## BACKGROUND OF RESPONDENTS

The first section of the Survey aimed to identify the respondent's profile, including contact details, details of affiliated organizations, professional background and expertise. The geographical background of respondents is summarized in Figure 1. There is a predominance of Asia-based respondents, mainly as a result of the strong commitment of local WHO partners and paediatrics associations of India, resulting in a high percentage of respondents with a professional background in "Child Health" (shown in Figure 2).

A substantial number of respondents are also based in Europe and North America, although a significant percentage of respondents based in developed countries are involved in on-going projects/activities in other regions, particularly in developing countries, as shown in Figure 7.

The professional background of respondents' shows – except for the high number of respondents from India with a Child Health background – a heterogeneous range of expertise. This demonstrates, first, the range of professional backgrounds of those involved in e-waste related research and activities and second, the variety of stakeholders reached by this survey

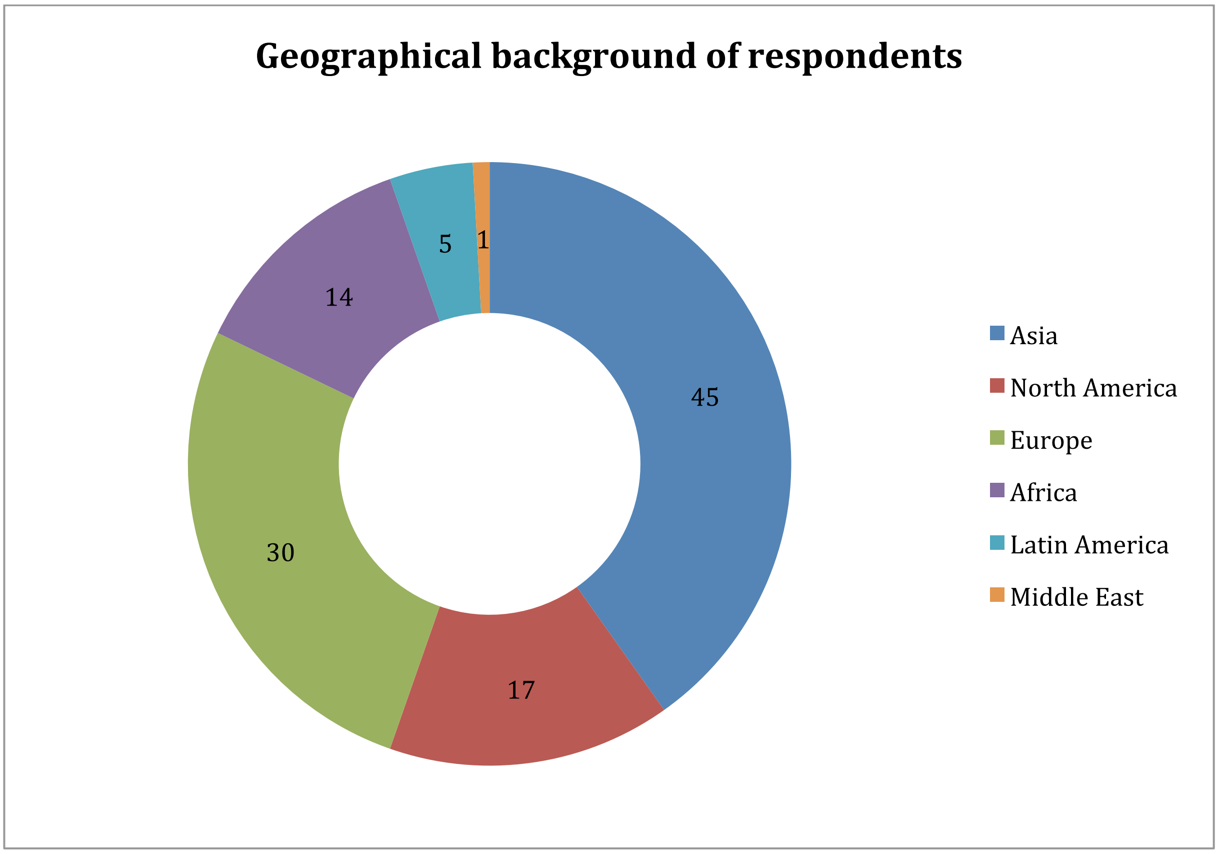


**Figure 1 – Geographical background of respondents.**

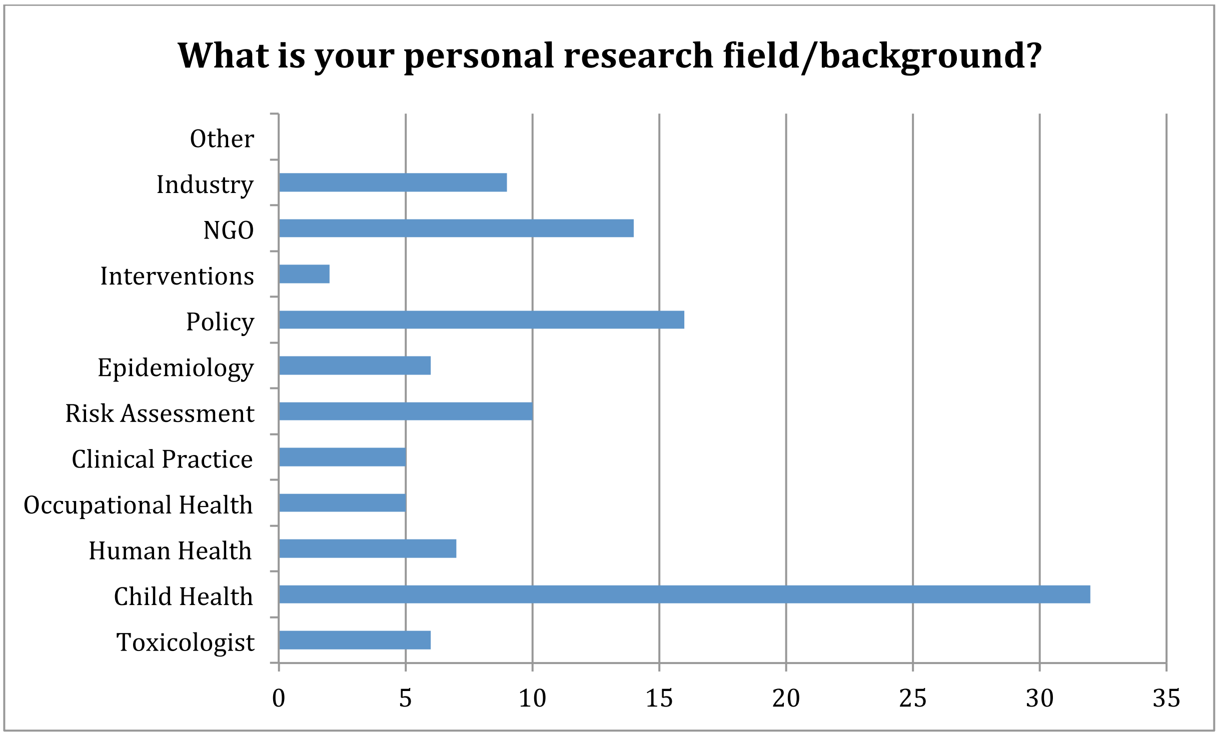


**Figure 2 – Professional background of respondents.**

It's crucial to highlight the importance of involving stakeholders with different professional experiences when addressing the multiple and unique challenges of e-waste management. . Such challenges might include, as non-exhaustive examples:

- The definition of sustainable operation's models appropriate for local social and economic conditions,
- The identification of proper technologies and training programs for operators,
- The set-up of sustainable financing mechanisms to fund the collection and proper recycling of e-waste and support awareness raising campaigns,
- The inclusion of health & safety perspectives in both the daily operations of e-waste management and the analysis of its impacts on society.

## RISK PROFILES

The survey asked respondents to evaluate the risks associated with exposure to different elements of e-waste equipment:

- Equipment, including cooling & freezing appliances, large household appliances, IT, consumer electronics, mobile phones and energy saving lamps. An open field was left to allow respondents to specify appliances not included in the list.
- Main components, including cathode ray tubes, compressors and lamps.
- Substances, including PCBs, PBDEs, PCDD/Fs, PAHs, PFAS, Lead, Mercury, Cadmium, Chromium, Combustion products and others.

For the 3 different questions each respondent was asked to rank the risk of each exposure, selecting from four options (a pair scale was chosen in order to avoid a majority of answers concentrated in the mean value): not important, less important, important and extremely important.

Figure 3 shows the overall results. It is important to highlight that under "other" few respondents listed equipment already included in the previous categories (overlaps) and in some cases explicitly mentioned batteries. Almost all forms of EEE equipment, components of EEE equipment and toxic substances were identified as important or extremely important risks.

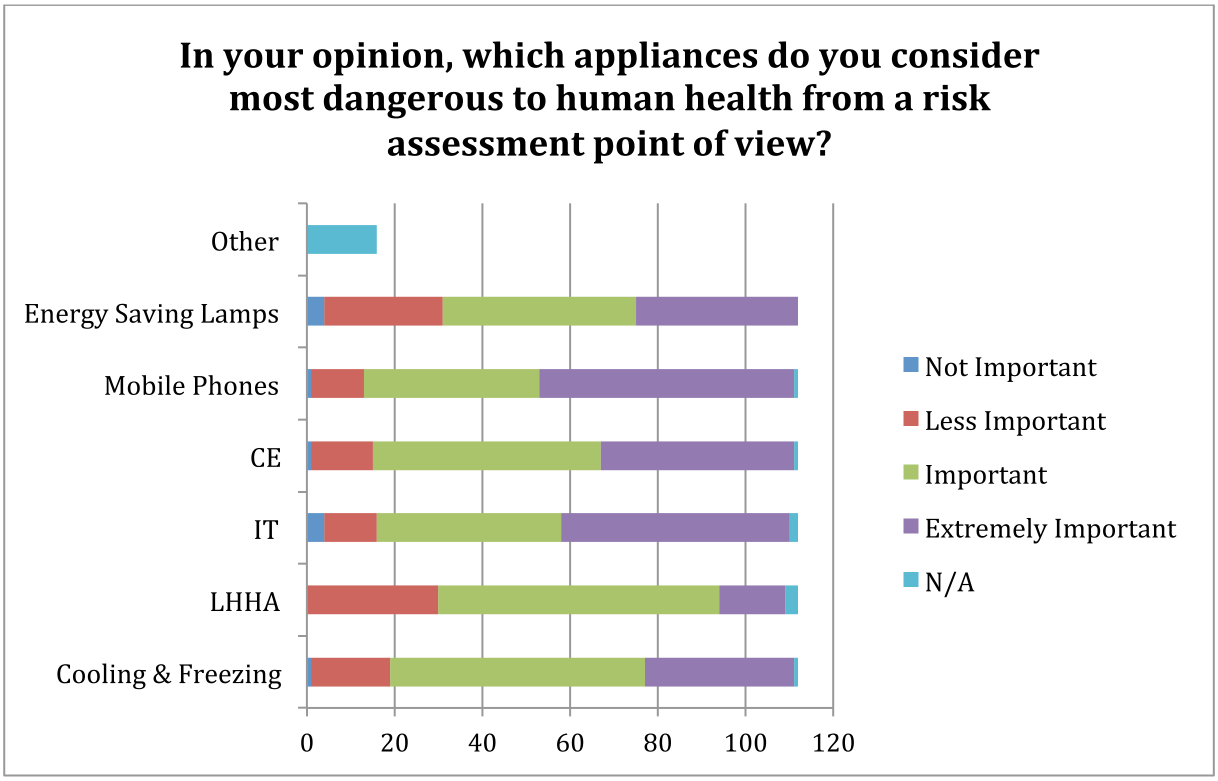


**Figure 3 – Assessment of risk's profile for different type of EEE .**

Figure 4 gives an overview of risks associated with specific substances. Again there's a general perception of high risk associated with almost all the substances.

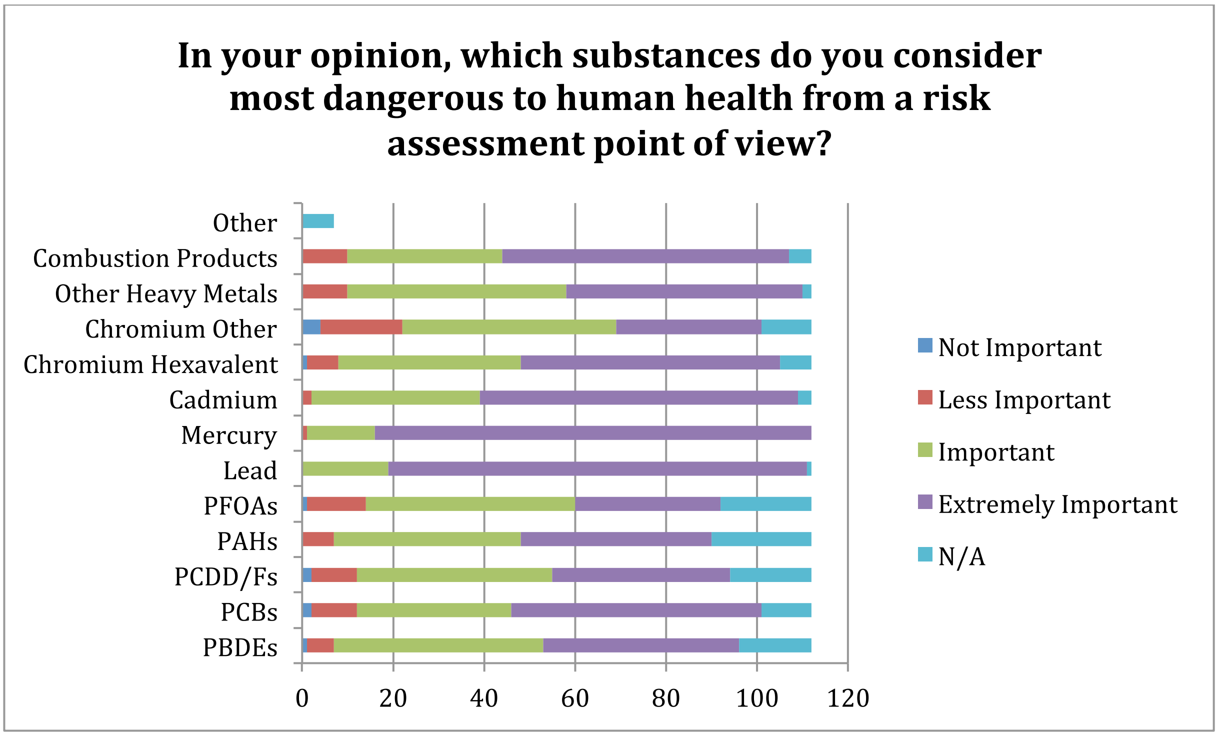


**Figure 4 – Assessment of risk profiles for different substances.**

Comparing Figure 3 and Figure 4 it is important to highlight the need to ensure consistency – potentially through awareness raising campaigns or tailored research – between the risks for human health associated with different substances (identified as potential root causes) and the appliances (or the treatment processes) leading to their release. As an example, despite almost all respondents ranking mercury as a substance of high importance (Figure 4), few respondents rated energy saving lamps as important (in Figure 3) although they are (together with LCD backlights) one of the main sources of mercury in e-waste.

## ON-GOING PROJECTS AND ACTIVITIES

Nearly 50 respondents have been (either at the time of response or in the past) involved in e-waste related projects or activities, as shown in Figure 5. The majority of respondents without actual involvement in e-waste projects/activities were Indian health professionals with child health backgrounds working in hospitals.

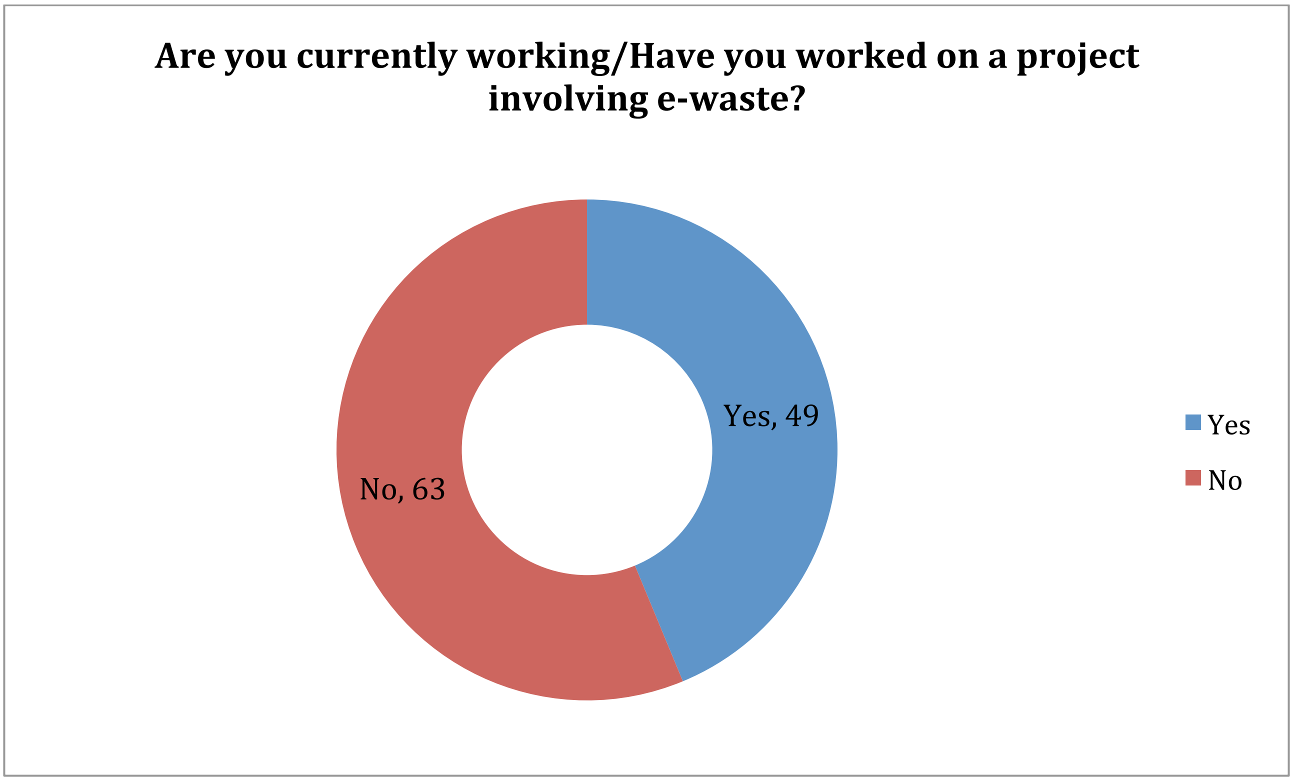


**Figure 5 – respondents involved in e-waste related projects/activities.**

Figure 6 displays the type of e-waste project in which each respondent has been involved. Similar to the results shown in Figure 2, the respondents have a variety of backgrounds. It should be noted that each respondent could select more than one option. A slight majority of respondents were involved in projects with a "policy" focus, while the responses provided in "Other" mostly overlapped with the currently listed categories.

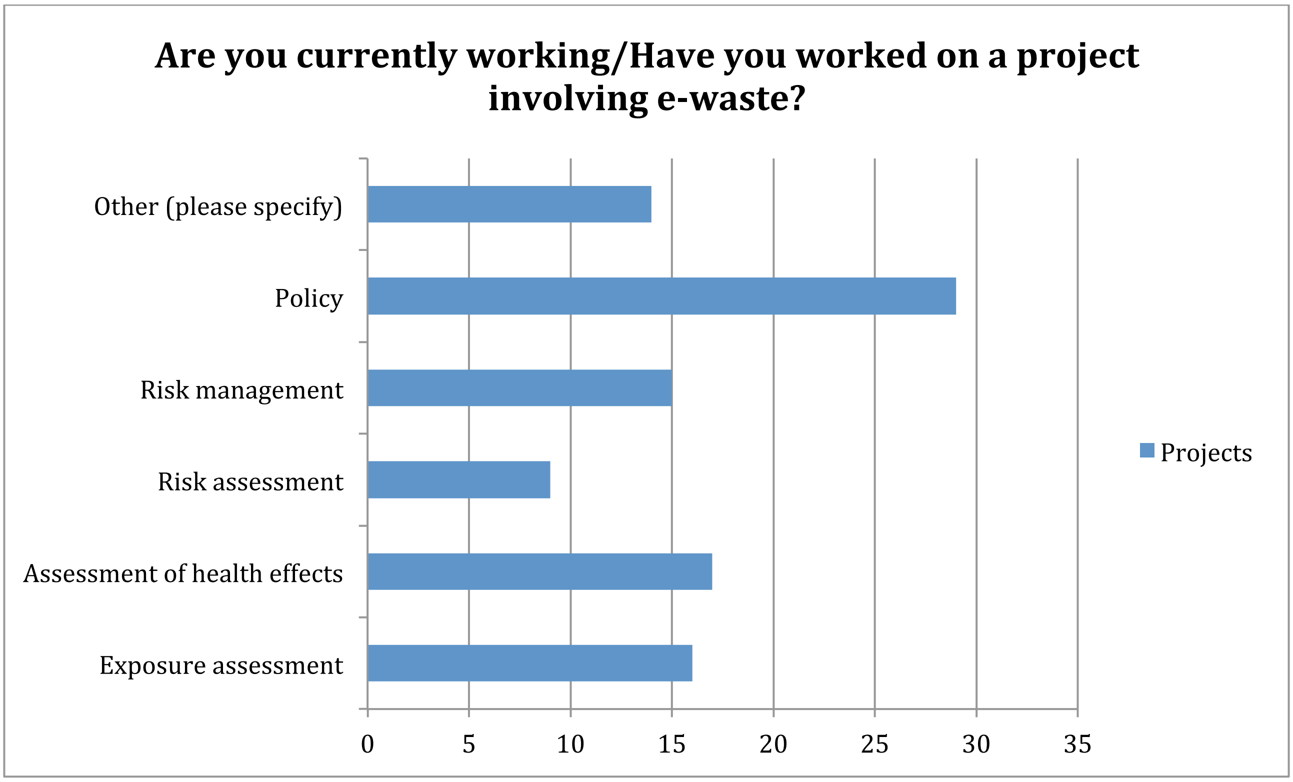


**Figure 6 – Approaches from respondents in e-waste projects/activities on-going.**

It should be noted that a disconnect exists between geographical background of respondents and target areas of projects/activities, particularly for respondents from Europe and North America (as seen in Figure 7). This is mainly due to activities of international organizations or agencies/entities based in developed countries supporting projects in other regions, primarily Africa and Asia (Figure 8).

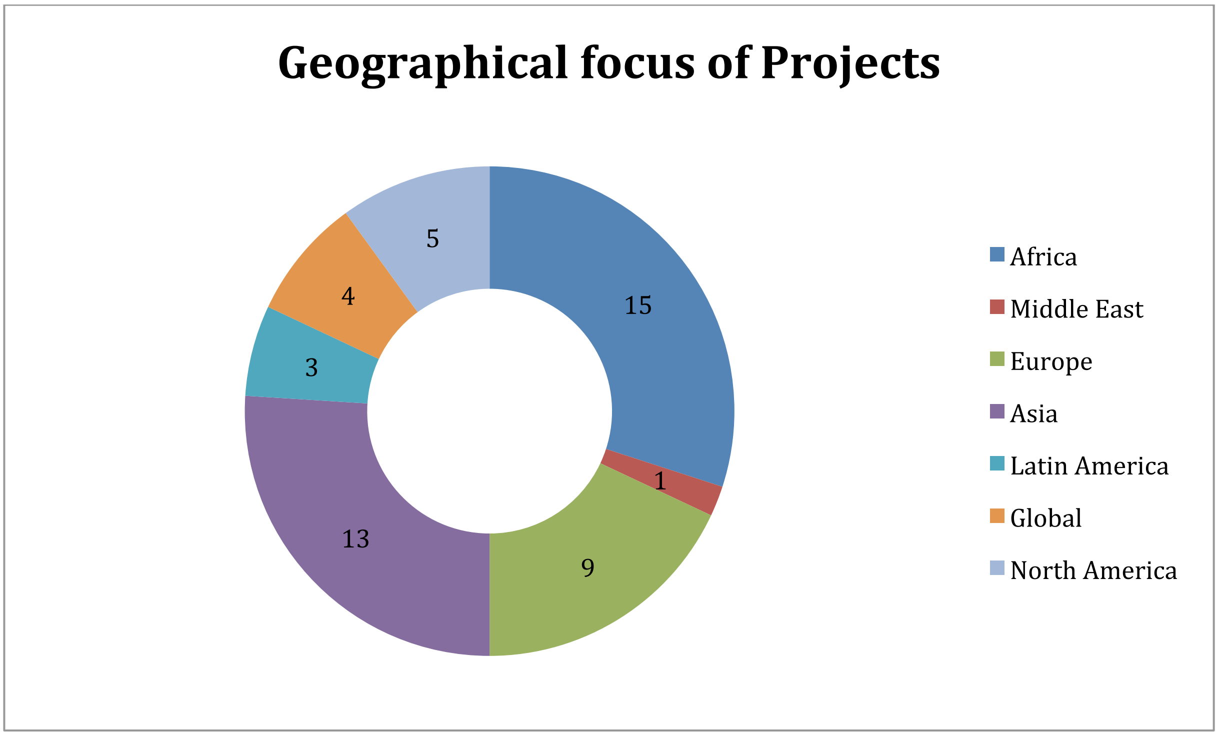


**Figure 7 – Geographical focus of on-going projects/activities.**

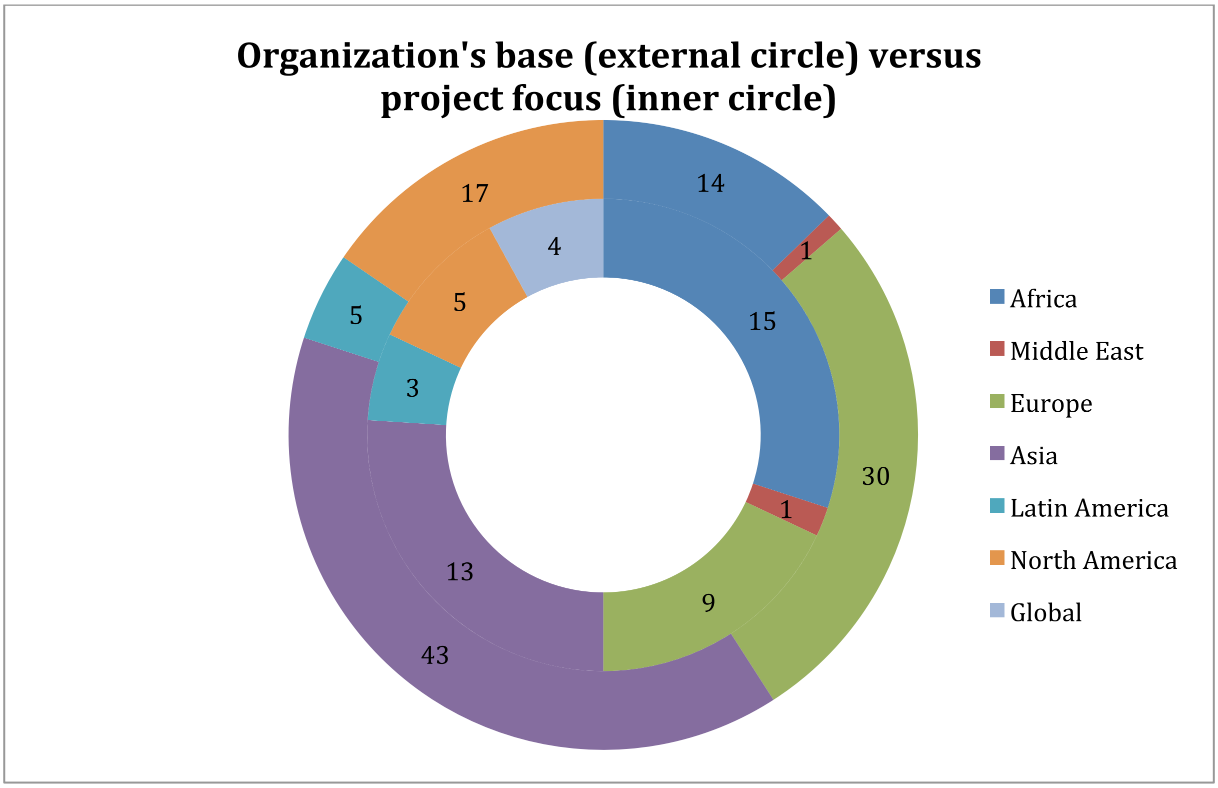


**Figure 8 – Comparison of organization's base versus geographical focus of projects/activities.**

The type of equipment included in projects was primarily IT/CE/mobile phones. This may be caused by:

- Historical perception of IT/CE as e-waste, compared to other devices like small household appliances, air conditioners, or tools. This perception is reflected in certain domestic legislation covering only select categories of electronic and electrical equipment;
- Broader penetration of such devices (compared to, for example, washing machines, hair dryers, electric cooking plates etc.) in developing countries compared to the distribution of EEE in households across Europe or North America;
- Intrinsic economic value of such devices when becoming waste that, in conjunction with higher penetration, is resulting in more waste being generated. This is results in more people, especially in developing countries, treating those products.

A growing number of projects are now addressing the challenges of the end-of-life management of cooling & freezing devices, which are associated with potentially severe environmental effects due to the release of ozone-depleting substances during treatment processes.

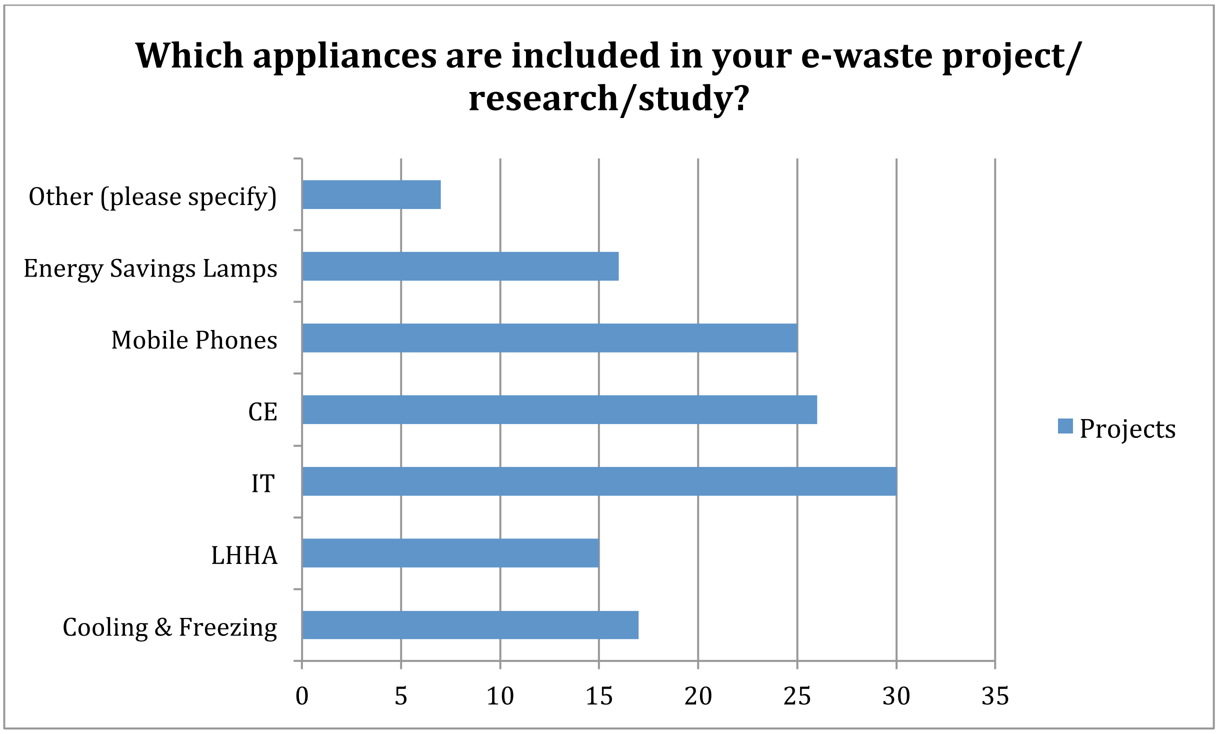


**Figure 9 – Types of EEE covered by scope of projects/activities.**

Additional details of projects/activities provided by some respondents lead to the following observations:

- A majority of projects are focused on traditional activities like capacity building in developing countries, impact assessment, transboundary shipments and other aspects related to the broader policy making process;
- Nearly 10 of the reported projects are focused on the relationship between specific substances (Pb, PBB, PBDE, Cd) and human health impacts;
- Few projects are focused on pollution in e-waste processing sites;
- Few projects target the consequences of informal recycling on health, which is most common in developing countries.

The main approaches used to measure exposures include:

- Desk research
- Air sampling
- Urine & blood analysis
- Soil tests
- Combined air, soil and urine analysis

Figure 10 shows that a number of projects are already investigating the consequences of e-waste exposure on children's health.

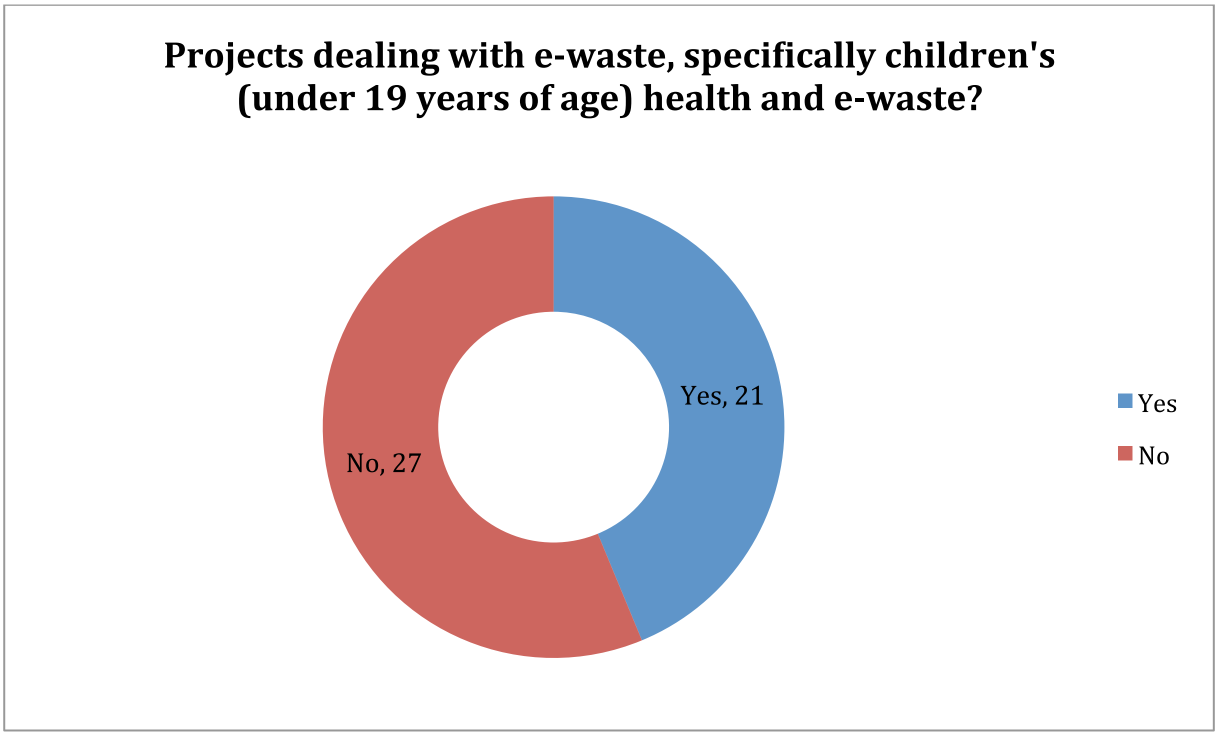


**Figure 10 – Projects dealing specifically with e-waste and children's health.**

## PROTECTIVE EQUIPMENT AND TOOLS USED

This section of the survey investigated the protective equipment and tools used in e-waste treatment. Although only 43 respondents were aware of actual use of protective equipment (as shown in Figure 11), more than 95% were convinced of the capability of protective equipment to reduce exposure.

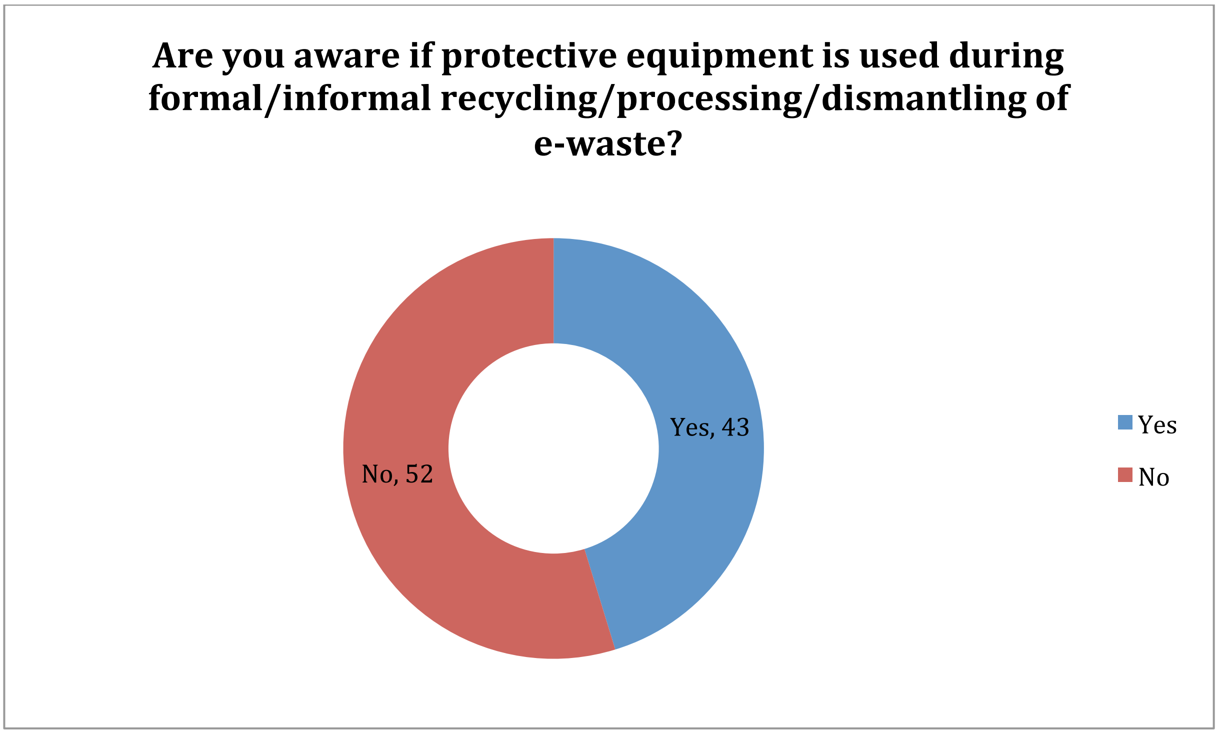


**Figure 11 – Awareness of respondents on usage of protective equipment.**

The comparison of protective equipment used as opposed to equipment recommended by all respondents (including those not aware if it was used or not) was quite consistent:

- Protective gloves and dust masks were the primary recommendations, followed by shoes and goggles.
- Aprons were viewed as slightly less important compared to the other types of protective equipment.

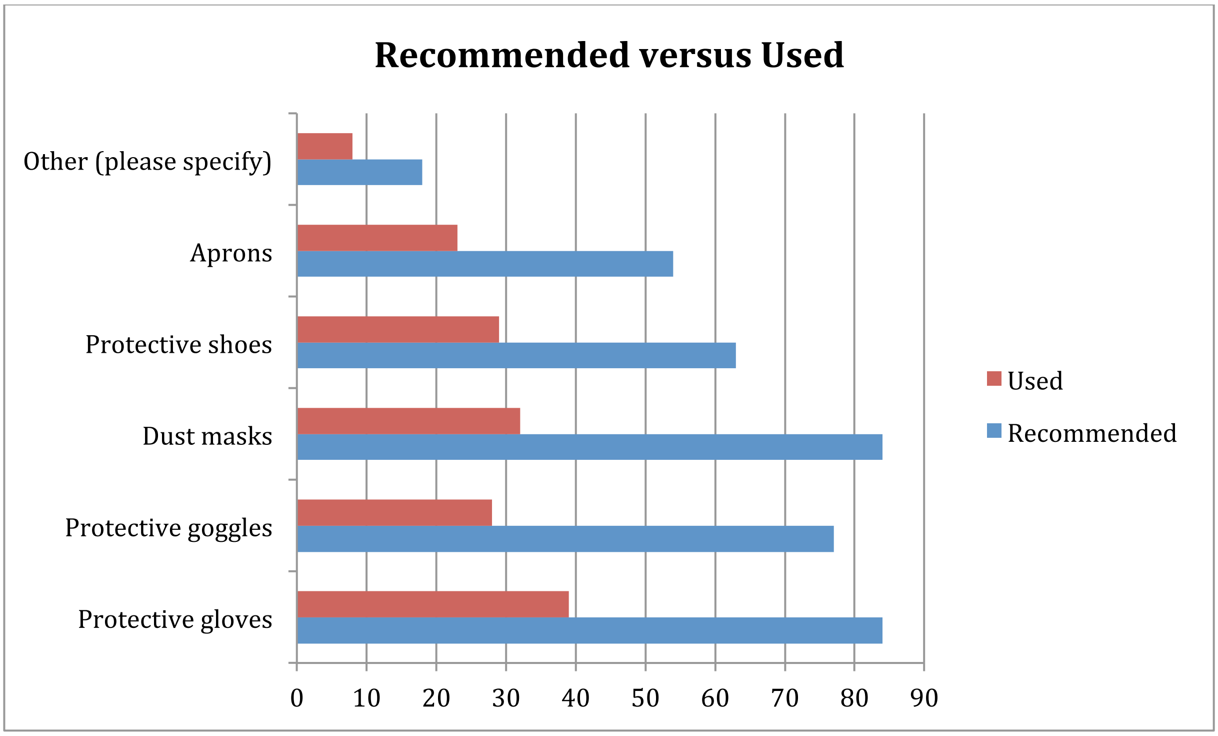


**Figure 12 – Comparison of used versus recommended protective equipment.**

Figure 13 displays different tools used for e-waste processing. Analysis of responses reveals some important aspects:

- There is a predominance of simple tools like hammers, screw drivers or cutters, primarily associated with manual disassembly;
- A high number of respondents listed burning and chemical extraction as the main techniques used.

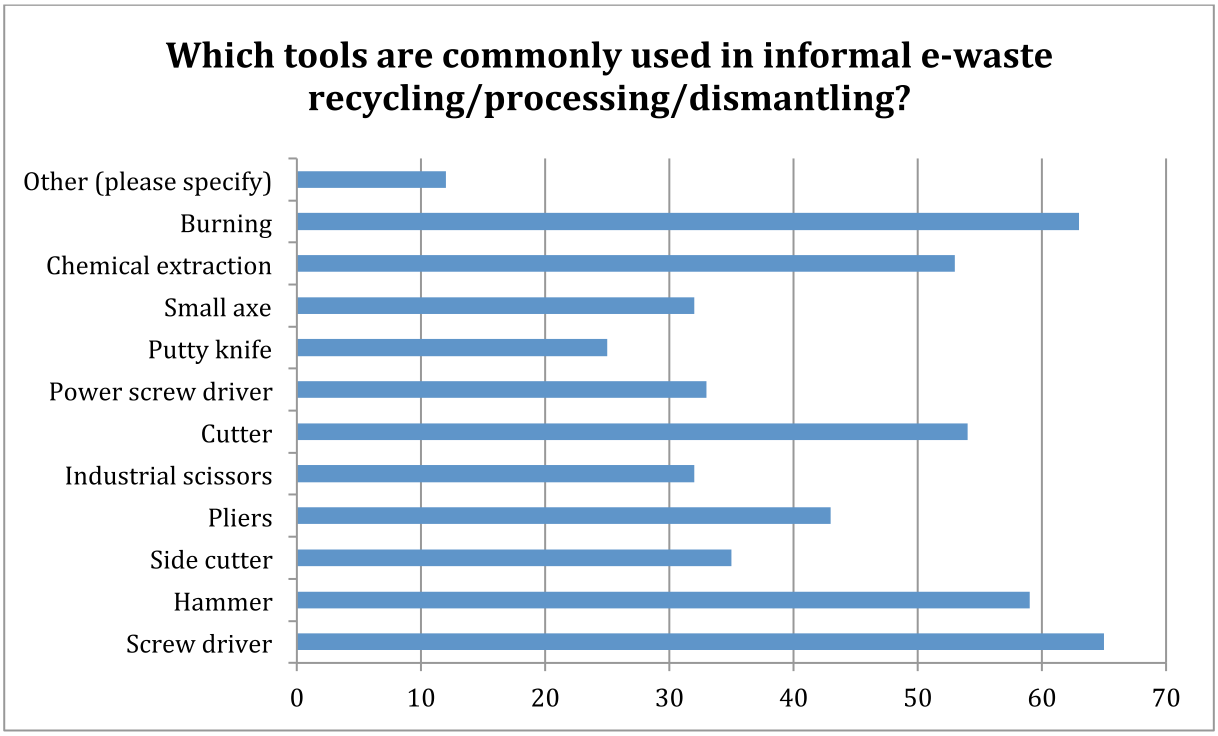


**Figure 13 – Tools used in e-waste processing.**

As previously highlighted it is important to link the tools and techniques used in e-waste processing with the potential hazardous substances released, and their potential health consequences (direct or indirect) to establish effective interventions.

## EXPOSURE'S RISK

Nearly 75% of respondents (Figure 14) measure outdoor exposures.

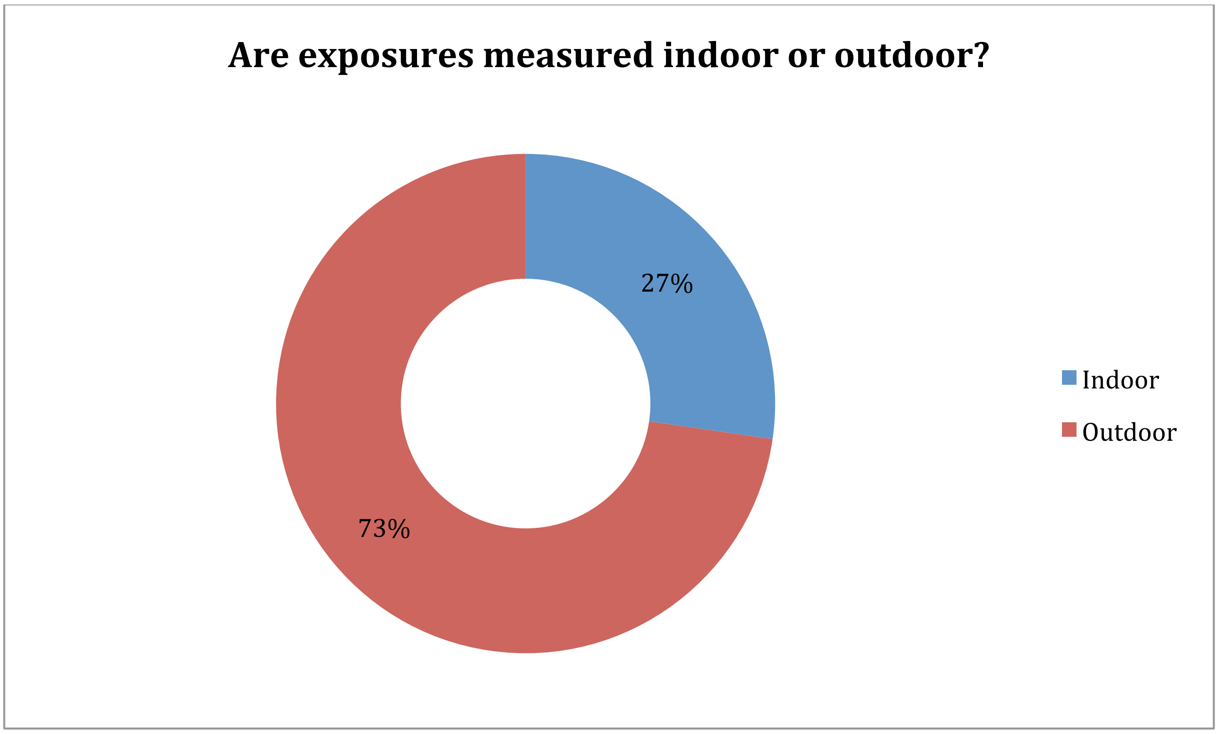

Figure 14 – Measurement of exposures.

The respondents identified a variety of associations between e-waste exposure and child health outcomes (as shown in Figure 15). The majority of responses in the "Other" category were clarifications. In some cases health outcomes were not investigated despite being expected. Some respondents indicated they would investigate health outcomes in future projects.

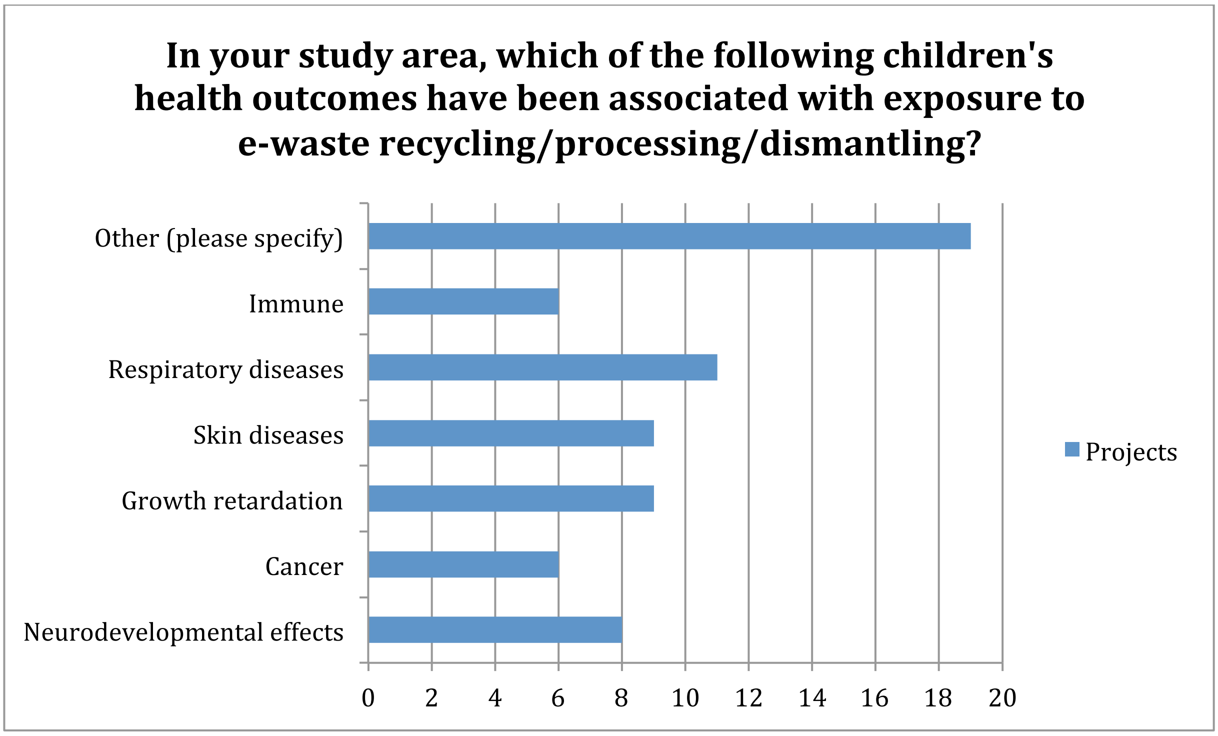


Figure 15 – Main consequences of children's exposure to e-waste recycling.

In addition to the categories available for selection, further examples were provided by respondents. These examples included a list of diseases or links between common practices in informal recycling and direct or indirect consequences on human health. Some examples included:

- general injuries,
- respiratory diseases from inhalation of dust or other substances,
- skin and eye injuries and irritations,
- safety accidents,
- excessive noise,
- dermal exposure,
- liberation of mercury vapours,
- hazards related to glass manipulation,
- exposure to neighbourhood e-waste recycling activities,
- infection of wounds,
- inhalation of noxious gases from burning,
- chemical burns,
- production of toxic chemicals by chemical extraction,
- ingestion as persons eat without proper washing of hands,
- critical foetal exposures.

## FUTURE OUTLOOK

Figure 16 displays the awareness of respondents about the existence of policies or recommendations aimed at reducing the risks of exposures during e-waste recycling.

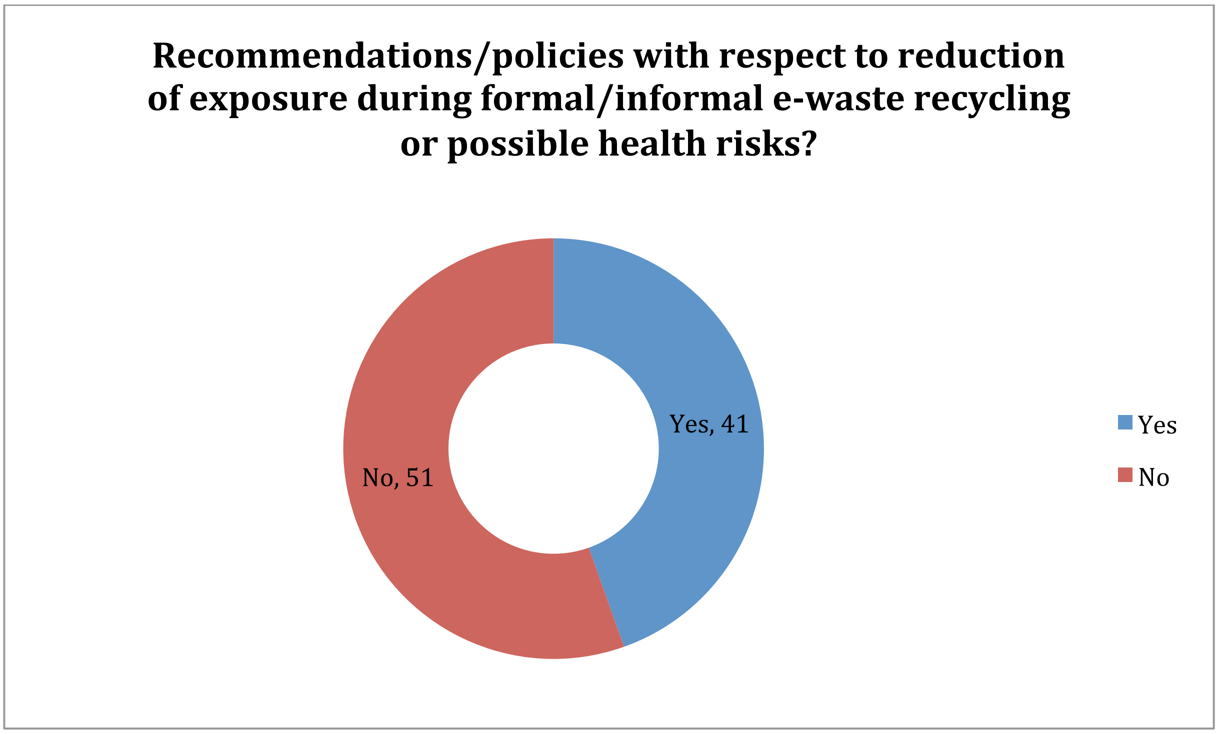


**Figure 16 – Existence of existing policies on health risks and e-waste recycling.**

Respondents aware of existing policies primarily referred to general waste management policies/regulations, general health and safety guidelines, or e-waste management manuals. The majority of respondents were not aware of the actual effectiveness of these policies. This is potentially due to the difficulties in applying a "command & control" approach in developing countries where most e-waste recycling is carried out in the informal sector. Informal recyclers often focus on cheap, fast extraction of the most valuable components of e-waste; protective processes or equipment that reduces profit or increases processing time is often viewed as undesirable.

Figure 17 suggests future research should encompass a wide range of topics.

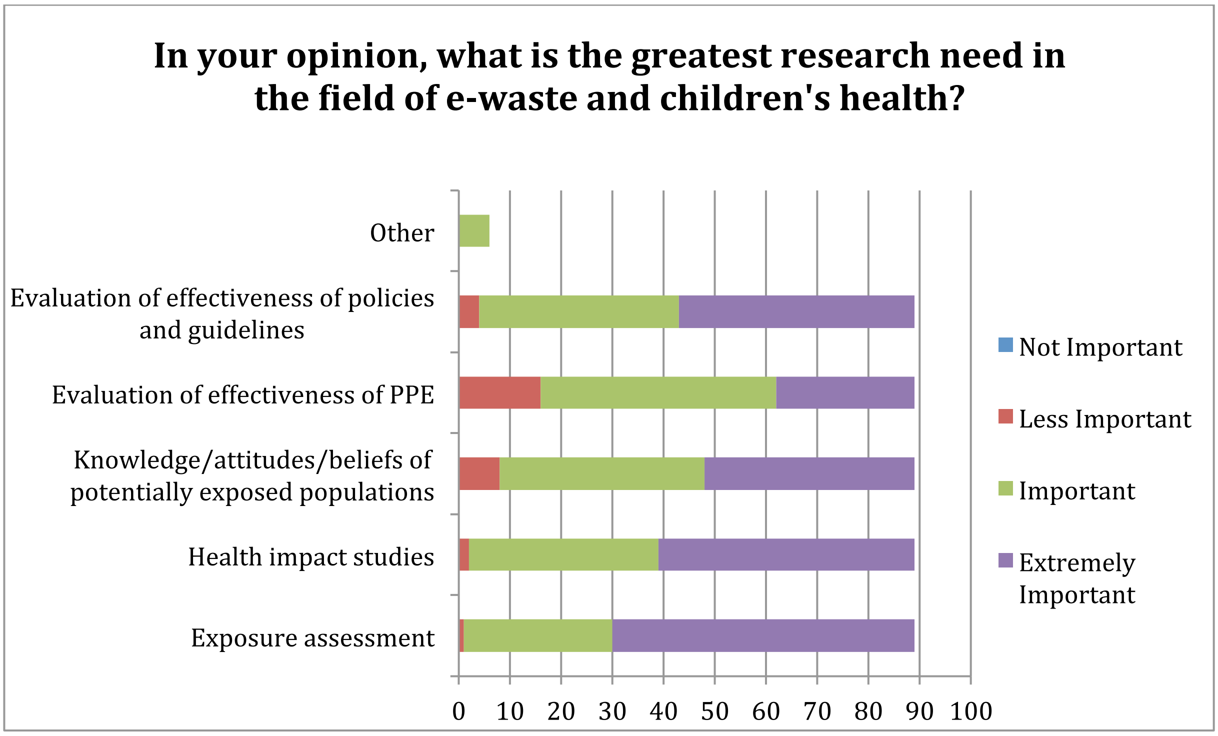


**Figure 17 – Outlook future researches needed.**

The existing network of respondents to the online survey represents a valuable group of experts with diverse experiences and backgrounds. Many are interested in joining a WHO-lead network of experts on e-waste exposures and children's health (as seen in Figure 18), and potentially expanding the focus to include adults.

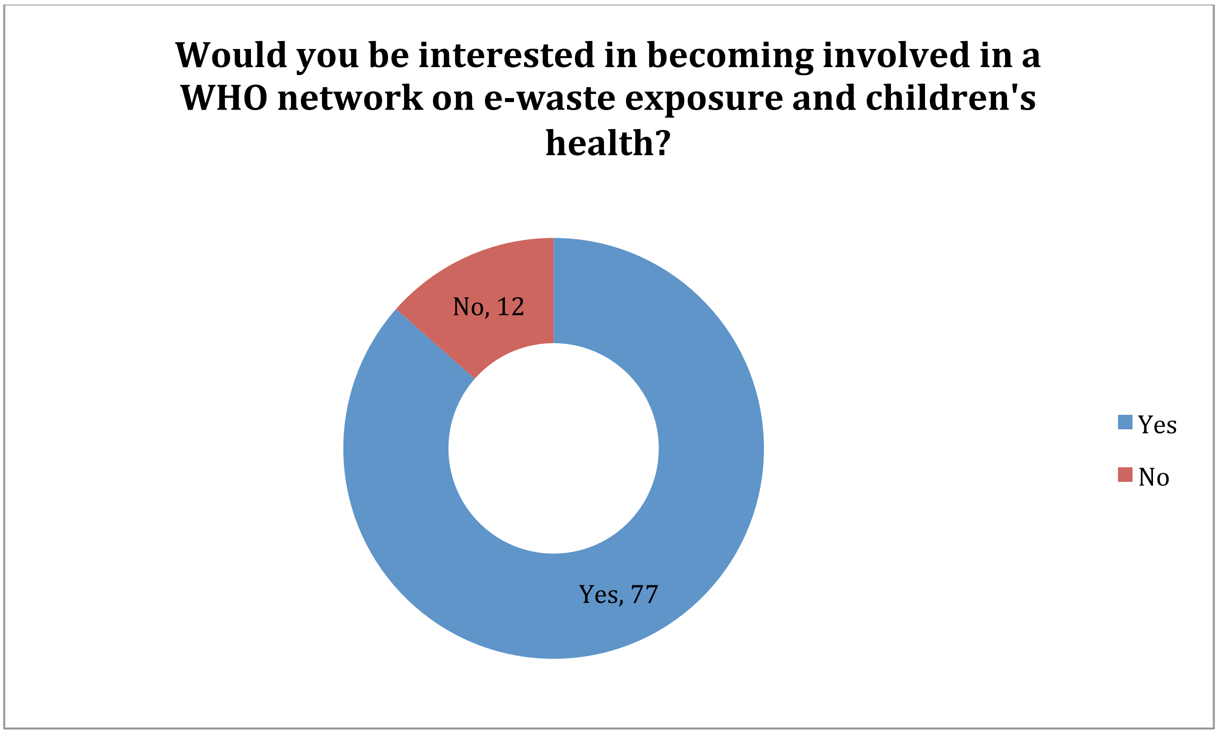


**Figure 18 – WHO network potential.**

Figure 19 suggests the need for a holistic approach to the threat of improper e-waste recycling to children's health. The ideal role of WHO is foreseen as wide ranging, including supporting primary research (sharing existing knowledge and research best practices), as well as facilitating communication between the scientific community and policy makers.

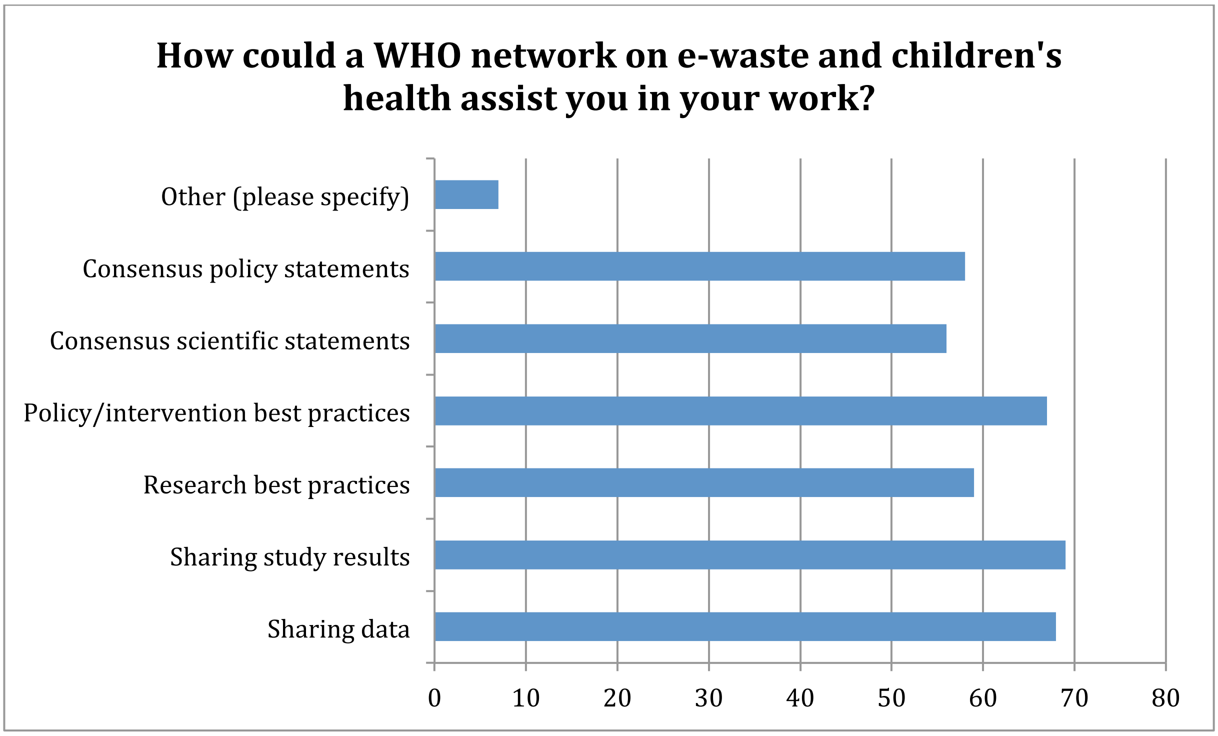


**Figure 19 – Outlook WHO role.**

To our knowledge this is the first global survey investigating the impacts of e-waste recycling on child health. The survey respondents: epidemiologists, toxicologists, child health experts, industry representatives, representatives of non-governmental organisations, and policy makers actively involved in the study of e-waste and health confirm that it remains a considerable global challenge.

WHO efforts to tackle the health issues related to e-waste management should synergise with on-going activities of other organizations and groups, utilizing and supporting the expertise of experts from all fields. A holistic approach, taking into account the multiple challenges of proper e-waste management in different regions, will be the most effective.

# ANNEXES